Insulation / Continuity Tester

MI 2123

User Manual

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METREL®

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CE Mark on your equipment certifies that this equipment meets the requirements of the EU (European Union) concerning safety and electromagnetic compatibility regulations

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1. General introduction

1.1. Features

The **SMARTEC Insulation / Continuity** Tester is a portable hand-held battery powered test instrument intended for testing of safety measures on mains installations. It operates on a SIMPLE and CLEAR basis.
The equipment is designed and produced with the extensive knowledge and experience acquired through many years of dealing with electrical installation test equipment.

General functions of the **SMARTEC Insulation / Continuity** Tester:
- Insulation Resistance measurement,
- Continuity measurement using test current of 200 mA in accordance with EN 61557 standard,
- Continuity measurement (continuous measurement) using test current of up to 7 mA,
- AC / DC Voltage and Frequency measurement.

Features:
- Wide range of Insulation Resistance test voltages (50 up to 1000 V DC),
- Automatic discharge of tested item after measurement completion,
- Automatic test voltage polarity exchange in Continuity ± 200 mA function,
- Continuity 7 mA function for inductive test items,
- Memories,
- PC connection.

A custom designed LCD offers easy to read results. Operation is simple and clear, the operator does not need any special training (except reading and understanding this Users Manual) to operate the instrument.
In order for the operator to be familiar with measurements in general, it is advisable to read the handbook **Measurements on electric installations in theory and practice**.
The instrument allows storage of test results. Professional PC SW enables simple transfer of test results and other parameters in both directions between the tester and the PC.

1.2. Applied Standards

Instrument operation:	IEC / EN 61557-1, IEC / EN 61557-2, IEC / EN 61557-4 DIN VDE 0413-1, DIN VDE 0413-4, DIN VDE 100 BS 7671 – 16th edition
Electromagnetic compatibility (EMC):	IEC 61326, Class B
Safety:	EN/IEC 61010-1 (instrument), EN/IEC 61010-2-31 (accessories)

2. Instrument description

2.1. Instrument Casing

The instrument is housed in a plastic casing, which maintains the protection class defined in general specifications. The casing consists of a main section, which includes the operator's panel and connectors and of a flexible cover.

Note! The cover is permanently fixed to the base section and cannot be detached.

2.2. Operator's Panel

The operator's panel consists of a custom LCD, a rotary switch, and a keyboard, see the figure below.

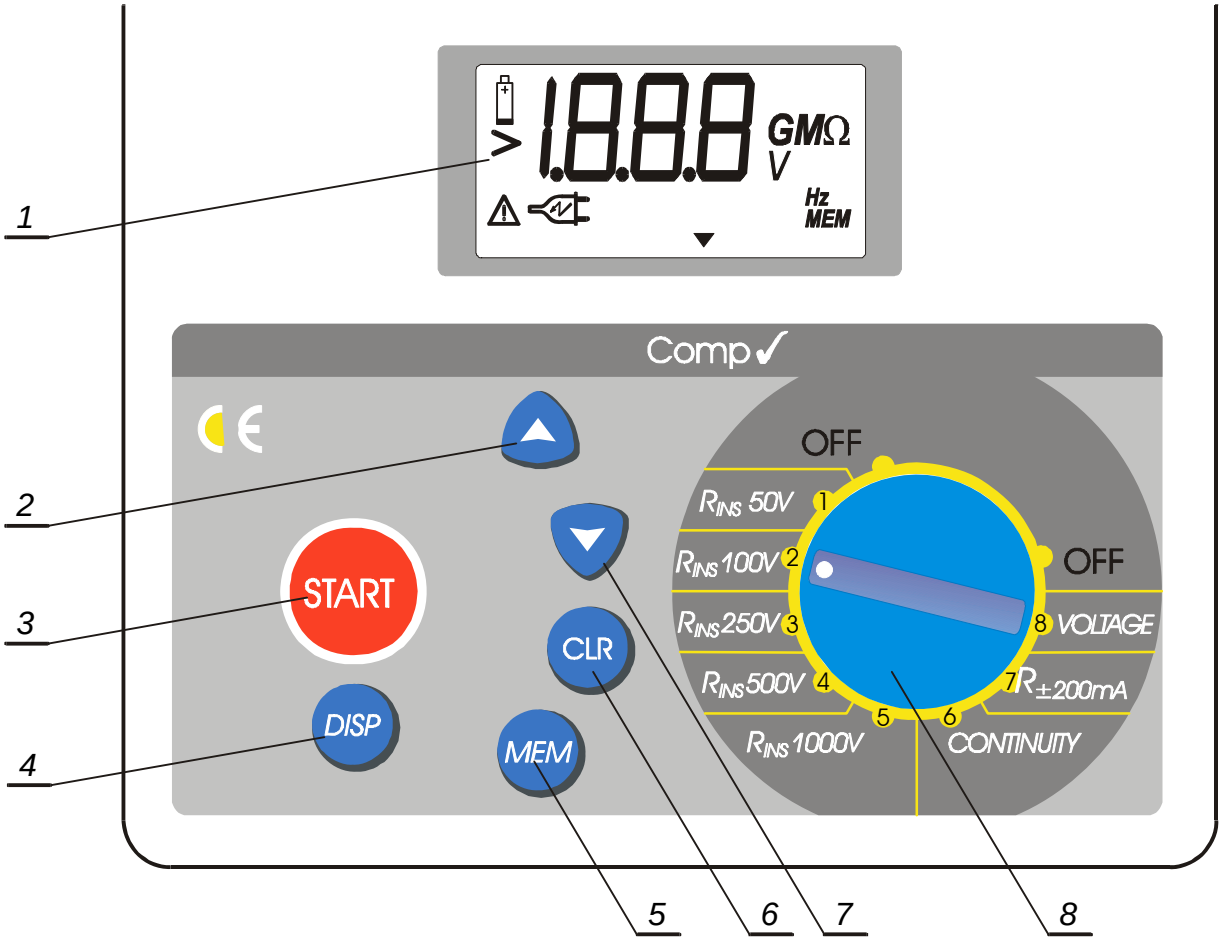


Fig. 1. *Front panel*

Legend:
1..... Custom designed **LCD**.
2..... **Up** key to increase storage group.
3..... **START** key to start any measurement.
4..... **DISP** key to display subresults of selected function.
5..... **MEM** key to store and recall results.
6..... **CLR** key to erase memorized results.
7..... **Down** key to decrease storage group.
8..... **Rotary switch** to select measurement function.

2.3. Connectors

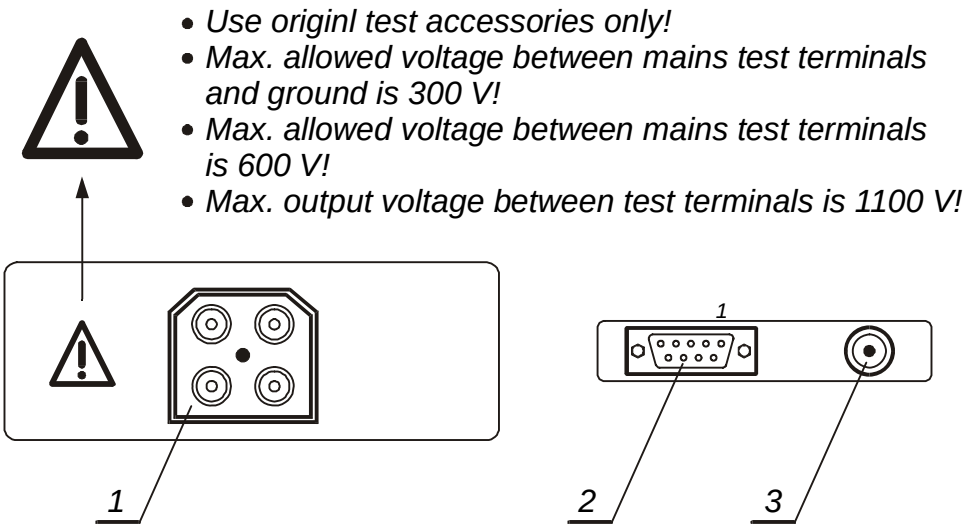

• Use originl test accessories only!
• Max. allowed voltage between mains test terminals and ground is 300 V!
• Max. allowed voltage between mains test terminals is 600 V!
• Max. output voltage between test terminals is 1100 V!
1
1
2
3

Fig. 2. *Connectors*

Legend:
1..... Test connector.
2..... RS 232 connector to connect the instrument to PC.
3..... Battery charger connector.

Test connector is intended for connection of the test cable and is accessible only when the instrument cover is lifted up. RS 232 and battery charger connectors are accessible only when the cover of the instrument is closed. For safety reasons both connector fields cannot be accessible at the same time, the cover of the instrument selects the accessible one.

2.4. Bottom Section

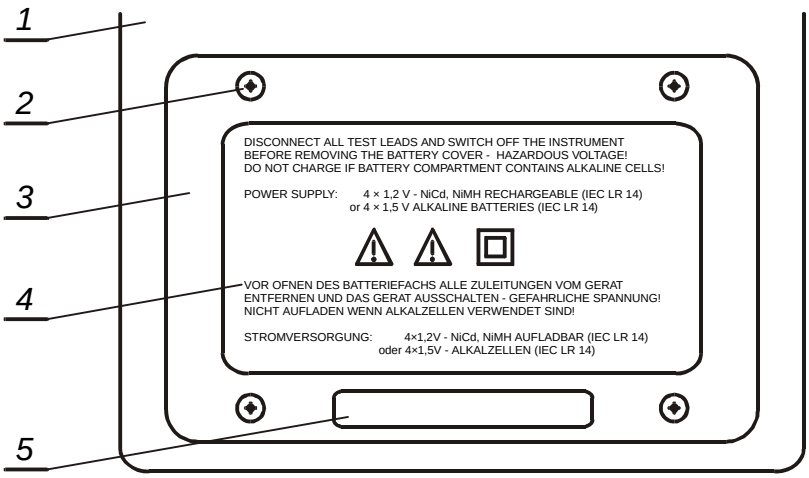

1
2
3
4
5
DISCONNECT ALL TEST LEADS AND SWITCH OFF THE INSTRUMENT
BEFORE REMOVING THE BATTERY COVER - HAZARDOUS VOLTAGE!
DO NOT CHARGE IF BATTERY COMPARTMENT CONTAINS ALKALINE CELLS!
POWER SUPPLY: 4 × 1,2 V - NiCd, NiMH RECHARGEABLE (IEC LR 14)
or 4 × 1,5 V ALKALINE BATTERIES (IEC LR 14)
VOR OFNEN DES BATTERIEFACHS ALLE ZULEITUNGEN VOM GERAT
ENTFERNEN UND DAS GERAT AUSSCHALTEN - GEFAHRLICHE SPANNUNG!
NICHT AUFLADEN WENN ALKALZELLEN VERWENDET SIND!
STROMVERSORGUNG: 4×1,2V - NiCd, NiMH AUFLADBAR (IEC LR 14)
oder 4×1,5V - ALKALZELLEN (IEC LR 14)

Fig. 3. *Bottom section*

Legend:
1..... Plastic housing.
2..... Screw (4 pieces) to fix the battery cover.
3..... Battery compartment cover.
4..... Battery cover warnings.
5..... Trade mark label.

2.5. Accessories

The instrument consists of standard and optional accessories. Optional accessories can be delivered upon request. See attached list for standard configuration and options or contact your distributor or see the METREL home page: http://www.metrel.si .

3. Warnings and Instrument Messages

3.1. Warnings

In order to reach highest level of operator's safety while carrying out various measurements and tests using the **SMARTEC Insulation / Continuity** Tester, as well as to ensure the test equipment remains undamaged, it is necessary to consider the following general warnings:

- **If the test equipment is used in a manner not specified in this Users Manual, the protection provided by the equipment may be impaired!**
- **Do not use the instrument and accessories if any damage is noticed!**
- **In case of blown fuse, follow the instructions in this Instruction Manual to replace it!**
- **Service intervention or calibration procedure is allowed to be carried out only by a competent, authorised person!**
- **Consider all generally known precautions, in order to avoid risk of electric shock while dealing with electrical installations!**
- **Use only standard or optional test accessories supplied by your distributor!**
- ⚠ **symbol at the instrument means "Read the Users Manual with special care!" The symbol requires an action!**
- ⚠ **symbol on LCD indicates that the measurement results show an irregular condition of the item under test which may present a hazardous live voltage.**
- **Disconnect all test leads and switch power off before opening Battery cover!**
- **Do not charge when alkaline batteries are fitted!**

3.2. Instrument Messages

Messages are generated on the LCD using special symbols and numeric segment combinations. The next figure shows all possible display segments and the table under the figure describes the messages.

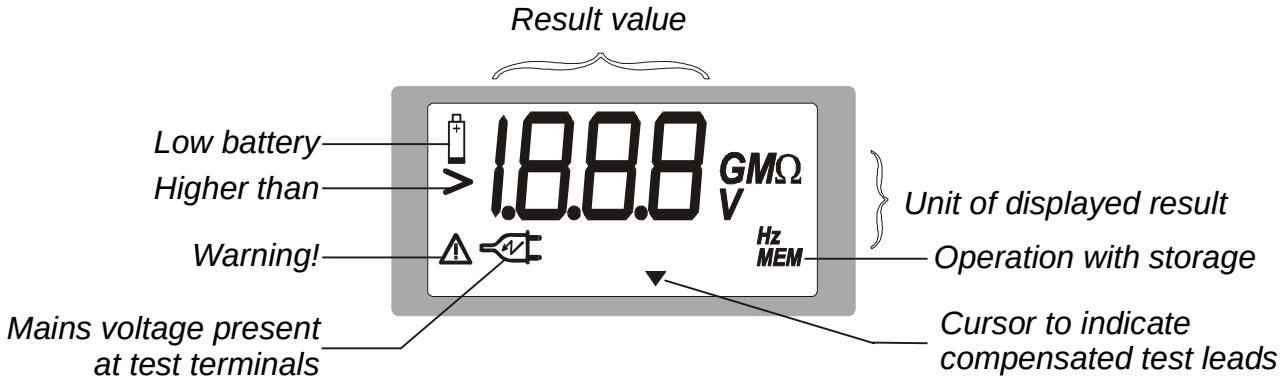


Fig. 4. *Display segments*

Description of possible display messages:

>1999	Result over range.
FUS	Blown fuse in Continuity functions only.
SEr	Active serial communication.
rES	*Reset of the instrument (erased memories).
End MEM	All storage locations occupied.
MEM	Operation with storage (store or recall).
no MEM	No result to be stored or no stored result to be recalled.
rCL	Recall function is entered.
Clr flashing	Confirm or abort clearing of last stored result?
Clr / ALL alternating	Confirm or abort clearing of all stored results?

Table 1*. Messages*

Note!

- * This indication appears after the first insertion of batteries, i.e. when there were no batteries in the battery compartment for a specific period of time (a few hours), or if the microprocessor detects an irregular state in its memory or if reset of the instrument has been performed.

4. Measurements

4.1. Insulation Resistance

Warnings!

- **Make sure that the item to be tested is disconnected (mains voltage disconnected) before starting the Insulation Resistance measurement!**
- **When measuring Insulation Resistance between conductors, all loads must be disconnected and all switches closed!**
- **Do not touch tested item while the test is in operation, risk of electric shock!**
- **Do not connect test terminals to an external voltage higher than 600 V AC or DC in order not to damage the test instrument!**
- **In case of capacitive test item (capacitive compensation of reactive power, long tested cable etc.), automatic discharge of the item may not be done immediately after finishing the measurement. Falling voltage will be displayed in that case – do not *disconnect test leads until the voltage drops below 50 V!***

The following figure shows connection of the instrument to tested item for testing of Insulation Resistance on electric installations. The measurement should be carried out between all conductors.

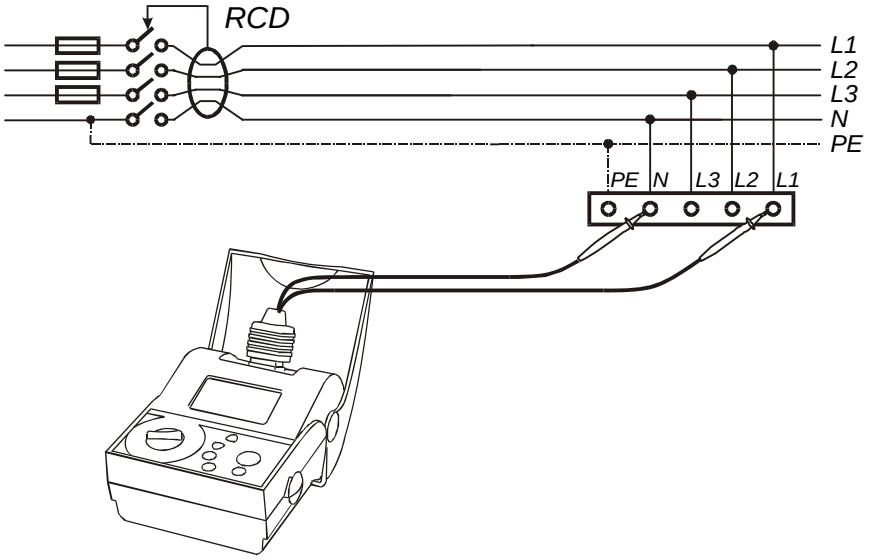
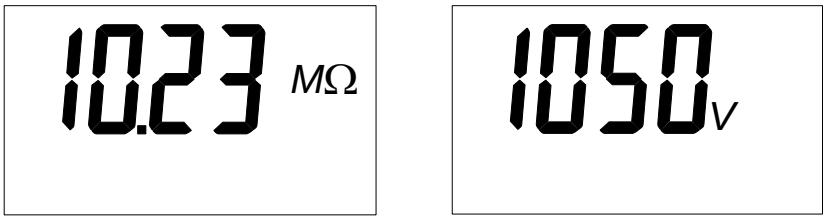


Fig. 5. *Connection of the instrument to item under test*

There may be also other items to be tested such as motor windings, ground cables, antistatic floor coatings, walls etc., see the booklet **Measurements on electric installations in theory and practice**

How to carry out the measurement:

- Connect test leads to item to be tested in accordance with figure 5.
- Select **Insulation resistance** function using appropriate test voltage by means of rotary switch knob.
- Press the **START** key and keep it pressed until the result has stabilised then release the key. With pressing the **START** key twice successively, continuous measurement starts to run.
- Read displayed result (Insulation Resistance).
- Check subresult (Actual test voltage) by pressing the **DISP** key.
- The result can optionally be saved using the **MEM**, **Up** and **Down** keys, see instructions in paragraph 5.2. Storage handling.



Example of displayed Insulation Resistance

Actual test voltage

Fig. 6. *Example of displayed result*

Notes!

- If an external voltage higher than 30 V AC/DC is present at test terminals, the Insulation Resistance measurement will not be carried out after pressing START key but the voltage will be displayed marked with ⚠ symbol.
- Tested item is discharged automatically after finishing the measurement and the actual voltage is displayed during discharge operation (only if high capacity is present).
- Positive pole of test voltage is attached to red test terminal.

4.2. R ±200mA

Continuity of protection conductors is to be measured, before mains voltage is connected to tested installation (new or adapted installation). Max. allowed resistance value depends on power of connected loads, used installation system (TN, TT) etc.

Test current of at least 200 mA is required by the EN 61557 regulation which is why this function is to be used whenever tests are to be done in accordance with this standard.

For additional general information concerning Continuity measurement, refer to the handbook **Measurements on electric installations in practice and theory**.

Warning!

- **Make sure that the tested item is de-energised (mains voltage disconnected) before starting the measurement! Fuse will blow if test probes are connected to mains voltage during the test.**

How to carry out the measurement:

- Connect test leads to tested item in accordance with the figure below.
- Select **R ±200mA** function by means of rotary switch knob.
- Make sure test leads are compensated, see the instructions in the next chapter.
- Press the **START** key and release it. To ensure the instrument's protection this function enables individual measurements (the START key should be pressed for each measurement).
- Read displayed result (Continuity), see figure 8.
- The result can optionally be saved using the **MEM**, **Up** and **Down** keys, see instructions in paragraph 5.2. Storage handling.

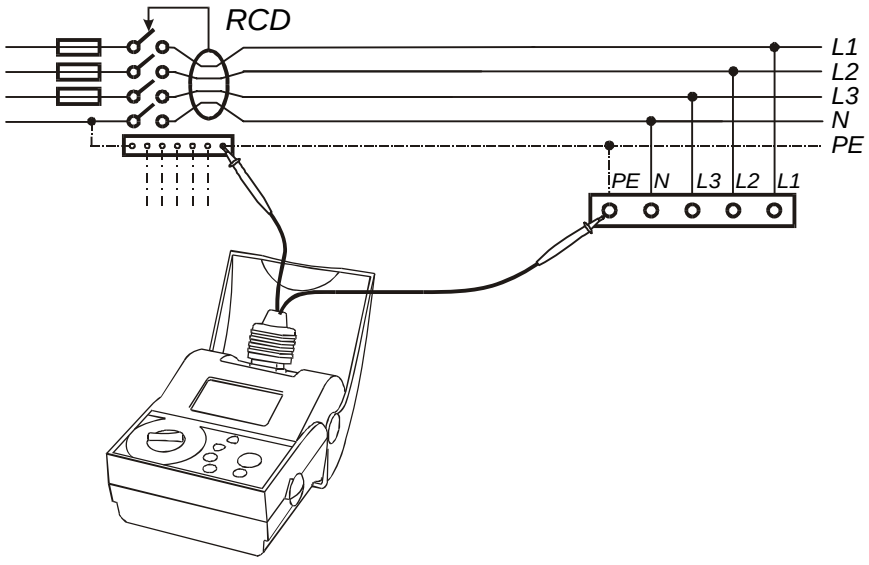


Fig. 7. *Connection of test leads*

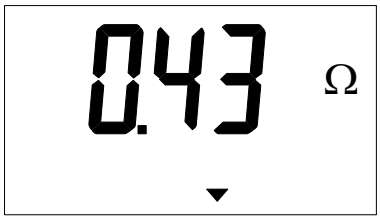


Fig. 8. *Example of* ***R±200mA*** *test result, test leads are compensated*

Notes!
- If an external voltage higher than 10 V AC/DC is present at test terminals, the **R ±200mA** measurement will not be carried out after pressing START key, but the voltage will be displayed, marked with ⚠ symbol.
- If test result is out of measurement range (open test leads), >1999 Ω message will be displayed!
- If indication **FUS** appears, replace blown fuse with new one. See the paragraph 6.3. Fuse replacement.

Compensation of test leads' resistance

In order to achieve high accuracy of test results it is advised to compensate resistance of the test leads before carrying out Continuity measurement. Especially it is advised to compensate test leads whenever the leads are changed for different ones.

How to compensate test leads:
- Select **R ±200mA** function.
- Short out test leads.
- Press the **START** key twice successively, total value of measured resistance (resistance of test leads + internal resistance) is displayed for a while then **0.00 Ω** is displayed. Cursor symbol on display (see the fig. 4) shows compensation state. Resistance of test leads is therefore compensated and the instrument is ready for Continuity measurements.

Notes!
- Max. resistance that can be compensated is 5 Ω. If total measured resistance is higher than 5 Ω (e.g. open test leads) then any compensation previously stored is ignored (compensation indicator disappears).
- Compensation of test leads' resistance can be done only in the **R±200mA** function.
- The indicator for compensation of test leads appears only after compensation has been performed and remains until the compensation is cancelled (e.g. by performing the compensation at open test leads).
- Compensation of test leads' resistance is stored and is used for both **R ±200mA** and **Continuity** functions.

4.3. Continuity

Continuity function is intended to be used when there are inductive loads to be tested, for example motor windings, transformers etc. or if there is no need to follow prescribed standards. It can be used also as an ordinary multi-meter (resistance range). This function enables continuous measurements (the measurement is running continuously after pressing the START key).

Test current of only up to 7 mA is used in order to save the battery energy.

For additional general information concerning Continuity measurement, refer to the handbook **Measurements on electric installations in practice and theory**.

Warning!

- **Make sure tested item is de-energised (mains voltage disconnected) before starting the measurement! Fuse will blow if test probes are connected to mains voltage during the test.**

How to carry out the measurement:

- Connect test leads to tested item.
- Select **Continuity** function by means of rotary switch knob.
- Make sure test leads are compensated.
- Press the **START** key and release it, measurement starts to run continuously.
- Press the **START** key again to stop the measurement.
- Read displayed result (Continuity), see the figure below.
- The result can optionally be saved using the **MEM**, **Up** and **Down** keys, see instructions in paragraph 5.2. Storage handling.

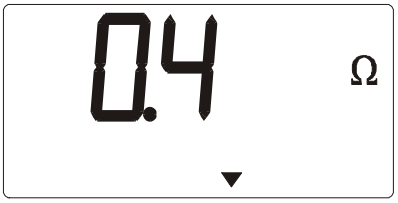


Fig. 9. *Example of* ***Continuity*** *test result, test leads are compensated*

Notes!

- If an external voltage higher than 10 V AC/DC is present at test terminals, the **Continuity** measurement will not be carried out after pressing START key, but the voltage will be displayed marked with ⚠ symbol.
- Compensation of test leads' resistance can be carried out in **R ±200mA** function only.
- If test result is out of measurement range (open test leads), >1999 Ω message will be displayed!
- If indication **FUS** appears, replace blown fuse. See paragraph 6.3. Fuse replacement.

Positive pole of test voltage is attached to red test terminal.

4.4. Voltage Measurement

How to carry out the measurement:

- Connect test leads to equipment under test.
- Select **VOLTAGE** function by means of rotary switch knob.
- Press the **START** key, continuous measurement starts to run.
- Read displayed result (Voltage), see the figure below. Displayed voltage may be exchanged with frequency by simply pressing the **DISP** key at any time, even whilst the measurement is running.
- Press the **START** key again to stop the measurement.
- Check subresult (Frequency of displayed voltage) by pressing the **DISP** key.
- The result can optionally be saved using the **MEM**, **Up** and **Down** keys, see instructions in paragraph 5.2. Storage handling.

Displayed result *Frequency*

Fig. 10. *Example of voltage measurement result*

Note!

- Do not connect test leads to a voltage higher than 600 V AC, to avoid possible damage to the instrument!

5. Operation with Results

5.1. Storing of Measurement Results

The memory for storing of measurement results has a stacking group organisation. The operator has the possibility to organise 1999 groups. Each group has the possibility to stack any measured result. In ‘storing result’ mode the operator selects a group and then the result is stacked together with all its parameters into the selected group. The figure below shows a graphic presentation of result grouping.

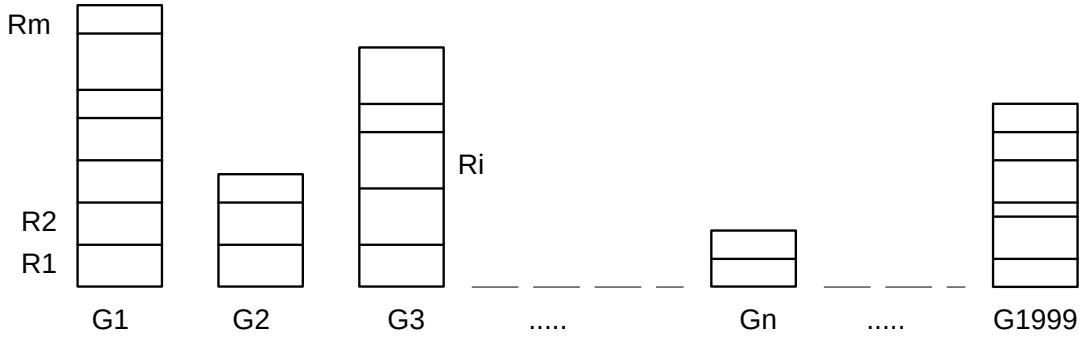


Fig. 11. *Storage locations organisation*

A set of information stored on location Ri (main result, sub-results and parameters) depends on selected function. There can be many results stored on the same location.

Practical Example of Storage Organization

For example: There is a standard house installation that has to be verified with regard to various electrical characteristics. The test plan should be prepared before any measurement is taken. The plan is based on wiring schematics and contains group definitions e.g. floor, room, wall socket and the related measurements in each group. The groups are assigned with numbers from 1 to 1999. When the test plan is defined the operator starts to run the measurements from group to group. The instrument asks every time for the group when storing test results. The result can be simply stored into the appropriate group if the group number already corresponds to selected measurement place in test plan, or the group number can be changed first and then the result stored.

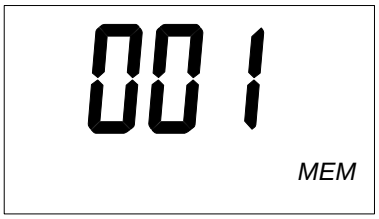
All results can be stored under a single group, e.g. No.: 1, if there is no need for grouping.

5.2. Storage Handling

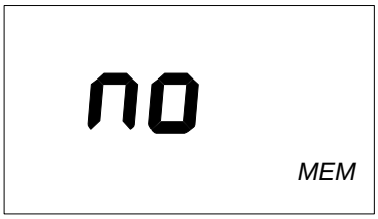
The following keys are intended to be used for storage handling: **MEM**, ↑, ↓ and **CLR**. There are the following possibilities of handling:

To store result (result is displayed):

a) Press the **MEM** key after completing the measurement. Last used group will be offered automatically, see the figure below.
b) Use ↑ and ↓ keys to change group number.
c) Press the **MEM** key again to store result.



Offered group number



Once stored - **no** possibility to store the same result again

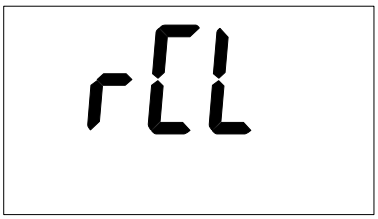
Fig. 12. *Group code and reaction to double storing of the same result*

Notes!
- Press the **START** key or change rotary switch position to cancel store procedure.
- Each result can only be stored once.

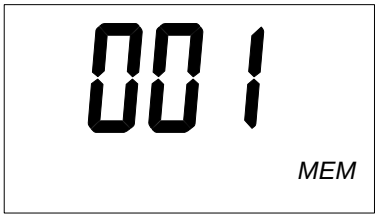
To recall stored results:

a) Press the **MEM** key just after changing rotary switch position, **MEM** mark will appear on LCD and **rCL** for a moment followed by the last accessed group number.
b) If there is no stored data **no** and **MEM** will flash for a second followed by selected function idle state display.
c) Use the ↑ and ↓ keys to change the group number.
d) Press the **MEM** key again once appropriate group is selected to recall stored result. If there is no result stored in selected group **no** and **MEM** will flash followed by the group number.
e) Use the **DISP** key to check sub-results and parameters**.**
f) To see previous or next stored results inside selected group press ↑ or ↓ key. Every entry is followed by the function code and then the result.
g) Press the **MEM** key to change group number and go to b).

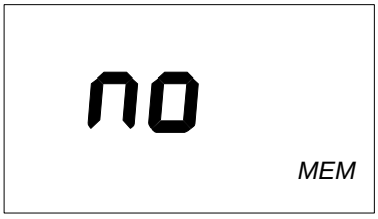
Note!
- Press the **START** key or change rotary switch position to cancel recall procedure.



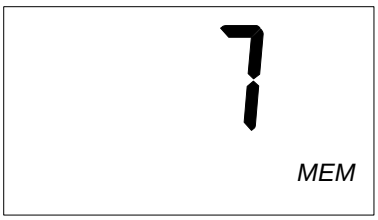
Indication when entering recall procedure



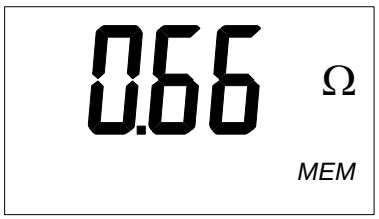
Last accessed group is offered



Storage buffer empty



Code of stored function (rotary switch position 7 = R±200mA)

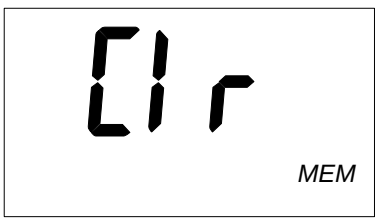


Stored result (R±200mA)

Fig. 13. *Displayed information during recall procedure*

To clear complete Memory:

a) Exit storage operation (storing or recalling), press the **CLR** key and keep it pressed until **Clr** and **ALL** messages start to alternate then release it.
b) Press the **CLR** key again to erase all stored results.



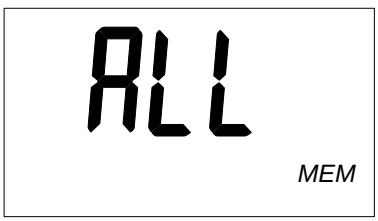


Fig. 14. *Waiting for confirmation*

Note!
Press the **START** key or change rotary switch position to cancel clear procedure.

To clear only last stored result:

a) Exit storage operation (storing or recalling), press the **CLR** key, **Clr** message appears, then release the key.
b) Press the **CLR** key again to erase last stored result.

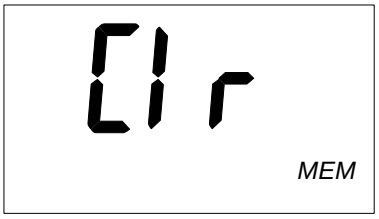


Fig. 15. *Waiting for confirmation*

Note!
- Press the **START** key or change rotary switch position to cancel clear procedure.

Stored Parameters

The following is a list of results, sub-results and parameters stored for each function.

Function	No	Stored data	Function	No	Parameters
RINS 50 V	1	Function code Insulation resistance Actual test voltage	**RINS 1000 V**	5	Function code Insulation resistance Actual test voltage
RINS 100 V	2	Function code Insulation resistance Actual test voltage	**CONTINUITY**	6	Function code Resistance
RINS 250 V	3	Function code Insulation resistance Actual test voltage	**R±200mA**	7	Function code Resistance
RINS 500 V	4	Function code Insulation resistance Actual test voltage	**VOLTAGE**	8	Function code Voltage Frequency

5.3. Data Transfer

Stored results can be transferred to a PC. A special communication program has the ability to identify the instrument and download the data.

How to transfer stored data:
- Connect PC COM port to the instrument with the serial communication cable.
- Turn power on to the PC and the instrument.
- Run the **smartlink.exe**. program
- The PC and the instrument automatically recognise each other.
- The program on the PC enables the following possibilities:
 -- download data;
 -- clear storage;
 -- change and download user data;
 -- prepare a simple report form;
 -- prepare a file to import to a spreadsheet.

The program **smartlink.exe** is a Windows 95/98 based PC software. Read file README.TXT for instructions on installing and running the program.

6. Maintenance

6.1. Inspection

To maintain operator's safety and ensure reliability of the instrument it is good practice to inspect the instrument on a regular basis. Check that the instrument and accessories are not damaged. If any defect is found please consult service centre, distributor or manufacturer.

6.2. Battery Replacement

The battery symbol on the upper left corner of the LCD indicates the battery state (Ubat < 4.2 V).
If a low battery state is indicated the batteries must be replaced to ensure accurate measurements.
The instrument is switched off automatically when battery voltage drops down to 4.0 V; **bat** indication is displayed before switching off.

Notes!

- **All four cells shall be replaced each time.**
- ⚠ **Turn power off and disconnect any measurement accessory connected to the instrument before opening battery cover.**

Nominal power supply voltage is 6 V DC. Use four 1.5 V alkaline cells, type IEC LR14 (dimensions: diameter = 26 mm, height = 50 mm).

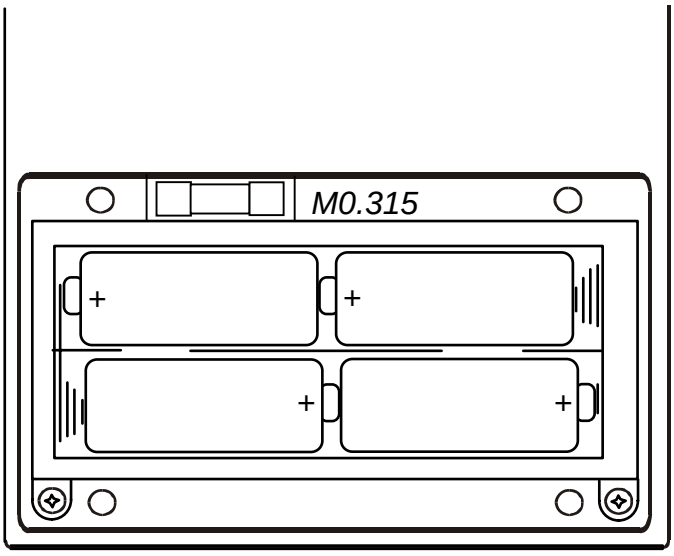


Fig. 16. *Correct polarity of inserted batteries and fuse position*

One set of full-capacity alkaline cells can supply the instrument for approx. 150 hours.

Rechargeable NiCd or NiMH battery can be used instead of alkaline. The instrument contains an additional connector for charging the batteries.

Notes!
- Insert cells correctly, otherwise test instrument will not operate and battery could be discharged, see the figure above for correct battery polarity!
- If the instrument is not to be used for a long period of time remove all batteries from the battery compartment.
- To ensure the integrity of the stored results do not leave battery compartment empty for more than 1 minute.

Warnings!
- **Do not charge when alkaline batteries are fitted!**
- **Take into account handling, maintenance and recycling requirements as defined by related standards and manufacturer of alkaline or rechargeable batteries.**

6.3. Fuse replacement

The instrument contains a fuse to protect $R_{\pm 200mA}$ and Continuity functions. The fuse can blow if an external voltage is connected to test terminals during the measurement. See the fig. 16. for fuse location.

Warning!
Replace blown fuse with prescribed one only (M0.315A) otherwise the instrument may be damaged.

6.4. Cleaning

Use a soft cloth slightly moistened with soapy water or spirit to clean the surface of the instrument and leave the instrument to dry totally, before using it.

Notes!
- **Do not use liquids based on petrol or hydrocarbons!**
- **Do not spill cleaning liquid over the instrument!**

6.5. Service

Repairs under or out of warranty time: Please contact your distributor for further information.

Note!
- Unauthorised person is not allowed to open the instrument!

7. Specifications

7.1. Measurements

Insulation resistance

Measuring range Riso (Un ≥ 500V): 0.12MΩ ÷ 20GΩ

Display range Riso (MΩ) Un: 500V, 1000V	Resolution (MΩ)	Accuracy
0.00 ÷ 19.99	0.01	±(3% of reading + 3 Digits)
20.0 ÷ 199.9	0.1	
200 ÷ 1999	1	
2.00k ÷ 19.99k	10	±(10% of reading)

Measuring range Riso (Un < 500V): 0.012MΩ ÷ 200MΩ

Display range Riso (MΩ) Un: 50V, 100V, 250V	Resolution (MΩ)	Accuracy
0.000 ÷ 1.999	0.001	±(5% of reading + 3 Digits)
2.00 ÷ 19.99	0.01	
20.0 ÷ 199.9	0.1	

Nominal output voltages: 50V, 100V, 250V, 500V, 1000V
Output voltage tolerance: +20%, -0%
Nominal output current: ≥1mA
Short circuit current: < 3mA

R±200mA

Measuring range R: 0.08 Ω ÷ 2000 Ω

Display range R (Ω)	Resolution (Ω)	Accuracy
0.00 ÷ 19.99	0.01	±(2% of reading + 2 Digits)
20.0 ÷ 199.9	0.1	
200 ÷ 1999	1	±3% of reading

Open-terminal test voltage: 4 - 7 Vd.c.
Test current for R ≤ 2Ω: > 200 mA
Compensation of test leads (up to 5Ω): yes
Automatic polarity exchange: yes
Measurement mode: single measurement

Continuity

Display range R (Ω)	Resolution (Ω)	Accuracy
0.0 ÷ 199.9	0.1	±(5% of reading + 3 Digits)
200 ÷ 2000	1	

Open-terminal test voltage: 4 - 7 V DC
Short-circuit test current: up to 7 mA
Measurement mode: continuous measurement

Voltage U

Display range U (V)	Resolution (V)	Accuracy
0 ÷ 600	1	±(3% of reading + 3 Digits)

Nominal frequency range DC, 45 – 65 Hz

7.2. General specifications

Power supply	6V DC (4 × 1.5V alkaline battery IEC LR14) or 4.8V DC (4 × 1.2V NiCd, NiMH rechargeable battery IEC LR14)
Battery charging	1.5 hours for full charge (using fast charger)
Auto power off	yes, approximately 10 min of no activity
Dimensions (w × h × d)	15.5 × 9.5 × 19 cm
Weight (without accessory, with battery)	1.3 kg
Display	custom LCD
Memory	approx. 1000 measurements
Computer connection	RS 232 (9600 baud, no parity, 8 bit data, 1 stop bit)
Protection classification	Class II (double insulation)
Over-voltage category	CATIII 300V
Pollution degree	2
Protection degree	IP 54
Working temperature range	0 ÷ 40 °C
Reference temperature range	10 ÷ 30 °C
Max. humidity	85 % RH (0 ÷ 40°C)
Reference humidity range	40 ÷ 60 % RH